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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/596,022	05/25/2006	Toshiharu Furukawa	FIS920030339US1	1812

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EXAMINER	
GEBREYESUS, YOSEF	

ART UNIT	PAPER NUMBER
2811	

NOTIFICATION DATE	DELIVERY MODE
07/22/2010	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

EFIPLAW@US.IBM.COM

Office Action Summary	Application No.	Applicant(s)	
	10/596,022	FURUKAWA ET AL.	
	Examiner	Art Unit	
	YOSEF GEBREYESUS	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 May 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 May 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Oath/Declaration

The Oath or Declaration filed on 5/25/2006 is acceptable.

Specification

1. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Objections

2. Claims 2 and 8 are objected to because of the following informalities:

3. Claim 2 on lines 6-7 recites the limitation "said trench" which appears to be "said at least one trench". It suggested to insert -- at least one --, in between the words "said" and "trench" for clarity and consistency.

4. Claim 2 on line 7 recites the limitation "said multiple carbon nanotubes" which appears to be "said multiple conductive carbon nanotubes ". It suggested to insert -- conductive --, in between the words "multiple" and "carbon" for clarity and consistency.

5. Appropriate correction is required.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

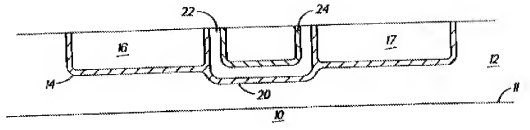
7. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. Claims 1-8, 10-15, and 17-19, are rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al. (US 2002/0151150, dated October 17th, 2002, filed October 26th, 2001; hereinafter Bernstein) in view of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereafter Smalley).

9. Regarding **claim 1**, figures 1-6 and related text of Bernstein discloses a substrate 10/12 (paragraph [0022]); a trench 18 (shown in figure 2, paragraph [0024]) in said substrate 10/12; multiple (plurality) conductive barrier layer 20/24 (paragraph [0025]) lining said trench 18; and a trench conductor 28 (paragraph [0030]), surrounded by and in direct contact with said conductive barrier layer 24, filling said trench 18, wherein said trench conductor 28 and said substrate 10/12 having a co-planar top surface.

FIG. 6



Bernstein lacks anticipation in not explicitly teaching the conductive barrier layer material is a conductive carbon nanotube.

However, in the same field of endeavor Smalley teaches, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0018] & [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive barrier layer material of Bernstein's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Bernstein's device in the above manner because purified carbon nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023] lines 1-4), thus enhancing the performance of the device (Smalley; paragraph [0018]).

10. Regarding **claim 2**, figures 1-6 and related text of Bernstein discloses a substrate 10/12 (paragraph [0022]); at least one trench 18 (paragraph [0024]) in said substrate 10/12; multiple (plurality) conductive barrier layer 24/20 (paragraph [0025]) lining said at least one trench 18; a trench conductor 28 (paragraph [0030]) filling said trench 18 and in direct contact with said conductive barrier layer 24; and a trench dielectric 22

(paragraph [0025]) between said conductive barrier layer 24 and sidewalls of said trench 18 and directly underneath and in contact with said conductive barrier layer 24.

Bernstein lacks anticipation in not explicitly teaching the conductive barrier layer material is a conductive carbon nanotube.

However, in the same field of endeavor Smalley teaches, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0018] & [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive barrier layer material of Bernstein's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Bernstein's device in the above manner because purified carbon nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023] lines 1-4), thus enhancing the performance of the device (Smalley; paragraph [0018]).

11. Regarding **claim 3**, figures 1-6 and related text of Bernstein discloses a layer of trench dielectric 22 on top of a bottom of said trench 18 and between said multiple conductive carbon nanotubes (conductive barrier layer) 20/24 and sidewalls of said trench, wherein the multiple conductive carbon nanotubes (conductive barrier layer) 24 form an open cylinder structure lining said sidewalls of said trench 18 through said layer of trench dielectric 22.

12. Regarding **claim 4**, figures 1-6 and related text of Bernstein discloses wherein the trench conductor 28 comprises a metal (copper) (Bernstein; paragraph [0029]),

contacting (electrically, capacitor forms electric field in the dielectric) said layer of trench dielectric 22 on top of said bottom of said trench 18.

13. Regarding **claim 5**, figures 1-6 and related text of Bernstein and Smalley disclose characterized in that the multiple conductive carbon nanotubes (conductive barrier layer) 20/24 and the trench conductor 28 are disposed in the trench 18 (Bernstein; paragraph [0024] & [00250]), and the trench conductor 28 is carbon free (copper) (Bernstein; paragraph [0029] lines 1-3).

14. Regarding **claim 6**, figures 1-6 and related text of Bernstein discloses characterized in that the substrate 10/12 is free of carbon nanotube catalyst materials (silicon and silicon dioxide or SOI substrate) (paragraph [0022] lines 1-5).

15. Regarding **claim 7**, figures 1-6 and related text of Bernstein and Smalley disclose characterized in that the multiple conductive carbon nanotubes (conductive barrier layer) 20/24 form a consistent lining along approximately the entire length of sidewalls of said trench 18.

16. Regarding **claim 8**, figures 1-6 and related text of Bernstein and Smalley disclose characterized in that the trench-type storage device is planarized so that a top surface of the substrate 10/12 is coplanar with respective top surfaces of the trench dielectric 22, the multiple conductive carbon nanotubes (conductive barrier layer) 20/24 and the trench conductor 28 (shown in figure 6 of Bernstein).

17. Regarding **claim 10**, figures 1-6 and related text of Bernstein and Smalley disclose further comprising a trench dielectric 22 between said multiple conductive carbon nanotubes (conductive barrier layer) 24 and sidewalls of said trench 18.

18. Regarding **claim 11**, figures 1-6 and related text of Bernstein discloses a substrate 10/12; one trench 18 in said substrate 10/12; (conductive barrier layer) 20/24 forming an open cylinder in lining said one trench 18; and a trench conductor 28 filling said open cylinder of said (conductive barrier layer) 24 and in direct contact with said (conductive barrier layer) 24, wherein said trench conductor 28 and said substrate 10/12 having a co-planar top surface.

Bernstein lacks anticipation in not explicitly teaching the conductive barrier layer material is a conductive carbon nanotube.

However, in the same field of endeavor Smalley teaches, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive barrier layer material of Bernstein's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Bernstein's device in the above manner because purified carbon nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023]), thus enhancing the performance of the device (Smalley; paragraph [0018]).

19. Regarding **claim 12**, figures 1-6 and related text of Bernstein discloses wherein the trench conductor 28 comprises a metal (copper) (Bernstein; paragraph [0029]), contacting (electrically, capacitor forms electric field in the dielectric) said layer of trench dielectric 22 on top of said bottom of said trench 18.

20. Regarding **claim 13**, figures 1-6 and related text of Bernstein and Smalley disclose characterized in that the conductive carbon nanotubes (conductive barrier layer) 20/24 and the trench conductor 28 are disposed in the trench 18, and the trench conductor 28 is carbon free (copper) (Bernstein; paragraph [0029] lines 1-3).

21. Regarding **claim 14**, figures 1-6 and related text of Bernstein discloses characterized in that the substrate 10/12 is free of carbon nanotube catalyst materials (silicon and silicon dioxide or SOI substrate) (paragraph [0022] lines 1-5).

22. Regarding **claim 15**, figures 1-6 and related text of Bernstein and Smalley disclose characterized in that the conductive carbon nanotubes (conductive barrier layer) 20/24 form a consistent lining along approximately the entire length of sidewalls of said trench 18.

23. Regarding **claim 17**, figures 1-6 and related text of Bernstein and Smalley disclose further comprising a trench dielectric 22 between said conductive carbon nanotubes (conductive barrier layer) 24 and sidewalls of said trench 18.

24. Regarding **claim 18**, figures 1-6 and related text of Bernstein and Smalley disclose further comprising a trench dielectric layer 22 directly underneath said multiple conductive nanotubes (conductive barrier layer) 24.

25. Regarding **claim 19**, figures 1-6 and related text of Bernstein and Smalley wherein said trench dielectric layer 22 lining at least a substantial portion of sidewalls of said trench 18 and said multiple conductive nanotubes (conductive barrier layer) 24 lining said trench 18 via said trench dielectric layer 22.

26. Claims 9 & 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al. (US 2002/0151150, dated October 17th, 2002, filed October 26th, 2001; hereinafter Bernstein) and Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereafter Smalley) in view of Yoshikazu Homma ("Growth of suspended carbon nanotube..." dated 09/16/2002, hereinafter Homma)

27. Regarding **claim 9 and 16**, the combination of Bernstein and Smalley substantially disclose the claimed invention except the multiple conductive carbon nanotubes (conductive material) are grown downwards into the trench.

However, in the same field of endeavor Homma discloses growing nanotubes downward (page 2263, 5th paragraph).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to grow the multiple conductive carbon nanotubes of the combination of Bernstein's and Smalley's device down wards as taught by Homma. The ordinary artisan would have been motivated to grow the nanotubes in the above manner for the purpose of forming vertical nanotubes without having arches at the top portion of the nanotube (page 2263 col. 2 lines 15-19).

28. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bernstein et al. (US 2002/0151150, dated October 17th, 2002, filed October 26th, 2001; hereinafter Bernstein) and of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereafter Smalley) in view of Widmann et al. (US 2001/0012658, dated August 9th, 2001, filed April 14th, 2001; hereinafter Widmann).

29. Regarding **claim 20**, figures 1-6 and related text of Bernstein and Smalley disclose wherein said trench dielectric layer 22 having a shape, lined by said multiple conductive nanotubes (plurality of conductive barrier layer) 20/24 across sidewalls of said shape, and filled by said trench conductor 28.

Bernstein and Smalley lack anticipation in not explicitly teaching the trench dielectric is formed of cylindrical shape.

However, in the same field of endeavor Widmann discloses a similar device wherein a trench dielectric is formed of cylindrical shape (paragraph [0014]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Bernstein's and Smalley's trench dielectric with a cylindrical shape as taught by Widmann. The ordinary artisan would have been motivated to modify the combination of Bernstein's and Smalley's device in the above manner in order to increase the surface area of the storage electrode which results in high capacitance of the capacitor.

Response to Arguments

30. Applicant's amendment filed on 5/13/2010, overcame the objection to the specification, the objections to claims 3, 5, 7-17, and the 35 U.S.C 112, 2nd, rejections to claim 12. Accordingly the objection to the specification, the objections to claims 3, 5, 7-17, and the 35 U.S.C 112, 2nd, rejections to claim 12 have been withdrawn.

31. Claims 1-5, 7-12, 15 and 17 as amended by the amendment, claims 6, 13-14, 16 and 18-20 as previously presented are currently in the application.

32. Applicant's arguments with respect to claims 1, 2 and 11 have been considered but are moot in view of the new ground(s) of rejection. The examiner would like to emphasize the new ground(s) or rejection is established because applicant has added the limitation "and in direct contact with" in claims 1, 2 and 11. The examiner is required to use the broadest reasonable interpretation consistent with the specification in order to examine the amended claims (MPEP 2111). The detail of the examination is listed in the office action.

Conclusion

33. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YOSEF GEBREYESUS whose telephone number is (571)270-5765. The examiner can normally be reached on Monday through Thursday 7:30 to 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lynne A. Gurley/
Supervisory Patent Examiner, Art Unit 2811

/YOSEF GEBREYESUS/
Examiner, Art Unit 2811

07/16/2010